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Design of a virtual PBL learning environment - Master in Problem Based Learning (MPBL)

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Abstract
The technological development has created a need for engineers who are oriented towards a global market, have the ability to be involved in interdisciplinary professional and intercultural teams, and who possess lifelong learning competencies. This entails a demand for new educational programmes that are more student-centred.

In order to support that development, a new master programme (60 European Credit Transfer System) the Master of Problem Based Learning (MPBL) has been established with the aim to improve engineering education. The master programme addresses staff and is an international distance programme capable of recruiting participants from all over the world. In terms of contents, it is organized exemplary according to the problem-based and project-based learning method and the participants have to experiment and develop their own teaching and curriculum. On the virtual learning side, it is also organized in conformity with the PBL learning principles. However, it has not been an easy task to develop a virtual environment supporting PBL learning principles. In this paper, we will explain the PBL learning principles and how these form the basis for the virtual environment.

Keywords: E-learning, Engineering Education, PBL, staff development, educational transformation

1. INTRODUCTION

The Master programme in Problem-Based Learning in Engineering and Science, MPBL [1] offers formalized staff development. The overall "outcome of this master programme is for the participant to gain the competences of being in charge of innovative teaching and educational experiments in order for the participants to develop an experimental practice which will lead to continuous improvement of the quality within engineering and science educations. The experiments should be based on problem based learning and aimed at groups of students with diverse backgrounds and characteristics, for example with regard to sex, class, cultural background and age" [2].

Three MPBL programmes have been developed by an international consortium: *Aalborg University, Denmark; Glasgow Caledonian University, Scotland; Hochschule Wismar, University of Technology, Business and Design, Germany; Lucian Blaga University of Sibiu, Romania; Pedagogical Network for Engineering Education, Denmark.* The development of the MPBL programme has been partly financed by the SOCRATES programme, ERASMUS projects 2003-2004: PBL-Engineering.

It is an international e-learning programme can be studied at full distance and thus the programme is capable of recruiting participants from all over the world. It is organized exemplary to fit its contents in with the problem-based and project-based learning method where participants have to experiment and develop their own teaching and curriculum. The overall intention with this programme is to offer formalized training for the process of changing traditional education.

The first module consists of the development of a teaching portfolio in which the students have to reflect on their previous and present teaching experiences and start reflecting on PBL. The progression through the whole programme was designed to support changing processes.

- Through reflection on and development of own teaching competencies in Module 1, to development of teaching experiments on a systemic level in the subsequent modules.
- Through the project work focus as it progressively shifts from planning via implementation to evaluation of the teaching experiments.
- Through the gradual shift from individual types of learning to group-based learning processes.

Programme overview

Module 1 - Development of Teaching Competencies

• PBL in Engineering and Science Education • Learning Theory for Engineering and Science Education • IT and the Study Programme • Engineering Didactics	10 ECTS
• *Project – Teaching Portfolio*	5 ECTS

Module 2 - Planning of Teaching Experiments

• Intercultural Learning and PBL • Development of Process Competencies • Scientific Methods in Engineering	9 ECTS
• *Project – Planning a Teaching Experiment*	6 ECTS

Module 3 - Implementation of Teaching Experiments. Specialisation

• IT in Teaching • Evaluation and Quality Development in Engineering and Science Education • Strategies for Management and Staff Development • Supervision • Engineering Competencies in a Global Information Society • Work Based Learning • PBL and Mathematics	9 ECTS
• *Project – Implementing a Teaching Experiment*	6 ECTS

Module 4 - Reflection and Evaluation

• Research Methods	3 ECTS
• *Project – Final Thesis*	12 ECTS

In this article, we will present the virtual learning system that we have created in order to fulfil the learning principles. The PBL principles are supported virtually by choosing Quick Place together with additional programmes serving to support visual learning and communication. Furthermore, we employ texts, streamed video, literature, discussion groups, and video sessions as resources in the self-directed learning process. A demo version is available online (http://www.mpbl.aau.dk/mpbl/demo/) [3].

2. PBL LEARNING PRINCIPLES

The MPBL programme adheres in exemplary manner to the PBL learning principles concerning contents and methods. The central theoretical learning principles in both problem-based and project-based learning deal with three dimensions: the problem, the contents, and the team [4].

The **learning approach** as problem and project-based learning means that *learning is organized around problems.* It is a central principle for the development of motivation. A problem makes up the starting point for the learning processes. It can be any type of problem, for instance a concrete realistic problem, or a theoretical problem. The problem serves as the basis for the learning processes because it determines the direction of the learning process and places weight on the formulation of a question rather than an answer.
Integrated in the problem approach is *learning in context.* The formulation of problems allows the learning contents to be related to the context, which promotes student motivation and comprehension.
Experience learning is also an implicit part of the formulation of problems and especially important in relation to which problems the students are attracted to and which problems the student formulates on the basis of his/her own experiences and interests.

The **content approach** concerns especially interdisciplinarity, exemplary learning and the theory-practice relation.
Interdisciplinary learning relates to the dimension of knowledge as the solution to the problem formulation, which may span across traditional subject-related boundaries and methods. This principle is critical for the organization of the teaching in that teachers often consider objectives within the known subject-oriented framework, rather than problems or situations.
Exemplary practice is concerned with ensuring that the student's learning output is exemplary in accordance with the framework of the objectives. This is an extremely central principle in that the student must engage in a deeper understanding of the selected complex problem formulation.
Theory-practice means that the students gain abilities to analyze and solve problems by using theories. During the entire learning process, they learn the art of analysis as they are required to analyze problems, analyze solutions, develop solutions, and analyze the impact of given solutions.

The **social approach** is the last core principle – this means team-based learning in which the majority of the learning processes take place in groups and teams. The team learning aspect underpins the learning process as a social act where learning takes place through dialogue and communication. But the students are not only learning from each other – they also learn to share knowledge and organize the process of collaborative learning. The social approach also covers the concept of *participant-directed learning*, which indicates who has the ownership of the learning process and, especially, the formulation of the problem. Process skills are therefore implicitly developed in order to handle group co-operation processes.

These learning principles have an impact on both the choice of teaching and learning methods and the creation of the virtual system. To practice these learning principles, dialogue and communication are needed among students in order to consider the team aspect.

Some of the above described learning principles concern the organization of the approach to learning, some the organization of a learning environment. Still, everything has to be at a distance, which makes the design of the programme even more challenging.

3. UTILIZING THE PBL PRINCIPLES

The MPBL programme has been on its way for 2½ years. During the planning phase, some of the first pilot courses were evaluated by an external evaluator interviewing the participants [5]. In general, the evaluation documented that the participants were very satisfied with what they gained from the courses, pleased with the emphasis put on the relation between theory and practice, and the participants felt able to use elements of the course directly in their own teaching.

The most difficult part for the participants were the technical problems – especially for participants working on their own. There have been problems with firewalls and access to on-line lectures. We learned to become much more coherent in our way of teaching in relation to the contents that we are teaching.

The primary lessons learned were that we have to:

- put more emphasis on the project. In the beginning, we were so focused on the contents that we forgot about the learning process. This has been a necessary part of the development and our own learning process.
- establish personal contact between a facilitator of the mini-project and the participants. Furthermore, experiences show that even experienced people need to be contacted and guided since, otherwise, the course will not be given priority [6].
- become much more aware of how we use the principles we teach for organizing students' learning processes.

These first experiences led to choosing another virtual system. Actually, at first, we used the UniFlex system, which was developed at Aalborg University at the Technical Faculty. This system cased a lot of trouble because participants had to zip and unzip their files. We realized that we had to find a more simple solution. Then we only developed homepages – and for single subject courses, these were perfect, but as a platform for a whole system, it was not sufficient. This led us to choosing Quick Place (QP).

Furthermore, the pilot courses gave us the courage to practise a much more action-oriented attitude as regards the facilitators – courage in the sense that we deal with adult participants, and it might sometimes be difficult to find the optimum balance in telling an adult what to do and how.

3.1 The Learning Approach

In order to address the learning principles of problem and context-based principles, the main study activity is the project where the participants can experiment. The participants have to define their own problems in their teaching or organizational practice. This means that the participants know the context of the problems and the problems might be experience-based. The definition of problems differs – but the participants have to wonder about aspects of their own teaching or organizational practice.

In order to support the project, several resources exist from which the participants can learn theories, methods for analyses, etc. The resources include:

a) Course Sessions: these include online lectures in the form of any combination of streamed videos, PowerPoint presentations, audio presentations, and text.

b) Discussion Forum: course participants can discuss the contents of the on-line lectures.

c) Reading Material: online articles, links to relevant literature on the Internet, and references to books.

d) The University Library, AUB: here they can receive assistance to finding further reading material including online literature in virtual databases connected to the library.

e) Facilitation: a university teacher from one of the MPBL partner universities will facilitate the mini-project.

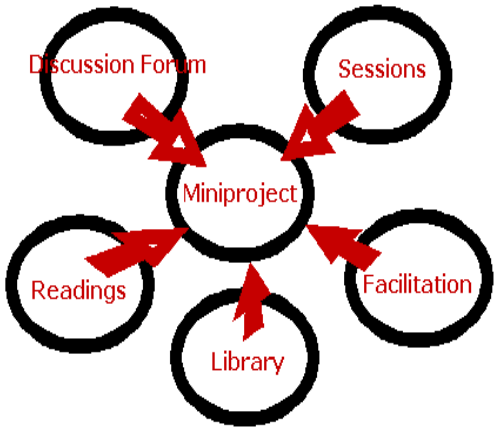
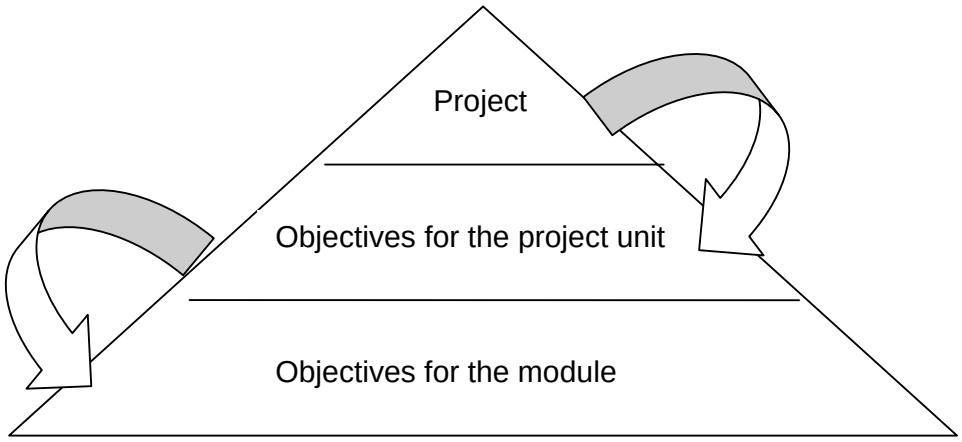


Figure 1 illustrates that the mini-project is central to the course and is supported by a variety of learning resources.

The main idea is to provide an overview of the available learning resources, and then the learner has to organize his/her own learning together with peers and develop a study plan. When will they take the courses – how often will they "meet" for discussion, etc. These study plans are rather important for the communication and the "contract" between facilitator and the participants and especially concerning the progression of learning.

3.2 The Contents Approach

The contents approach involves three principles: interdisciplinarity, exemplarity, and theory-practice relation. All have to do with the contents of the project and, especially, the problem that the participant chooses to work on. How much interdisciplinary learning there will be is totally dependent on the problem and what kind of knowledge will be needed in order to analyze and solve the problem. The exemplary learning is automatically built into the MPBL programme as the project and the courses together form a project unit with special objectives.



The project has to be exemplary to the project unit and the project unit has to be exemplary to the objectives of the module – and, in the end, to the overall objectives for the MPBL programme. Theory and practice lie in the demand that participants choose problems from their own practice.

3.3 The Social Approach

The social approach of the PBL learning principles is a PBL core principle. At a distance, this might prove to be challenging.

Throughout the entire programme, the participants have to work in teams – either study groups where they can give peer assessment to each other, or in real project groups where they have to submit a project together.

For this we need a virtual system that supports communication and collaboration. We have considered several systems – and each system that we have tried out has had it advantages and disadvantages. Aalborg University supports two systems for distance learning: First Class and Quick Place (QP). We decided to choose the QP system since:

- QP provides the possibility of arranging group rooms and assign manager rights to all group members. This allows the participants to obtain ownership of their own room.
- QP provides possibility of employing both asynchronic and synchronic communication. Asynchronic communication is used for discussion boards, e.g..
- QP's synchronic communication is the integration of Same Time with a chat function and video/audio communication tools. Furthermore, it allows participants to work on the same document on the screen – enabling them to share documents.
- QP is easy to learn – both how to navigate in it and how to actually use it.
- QP is supplemented by SKYPE. Use of SKYPE is free and opens up for possibilities of audio meetings between four persons or video meetings between two persons.

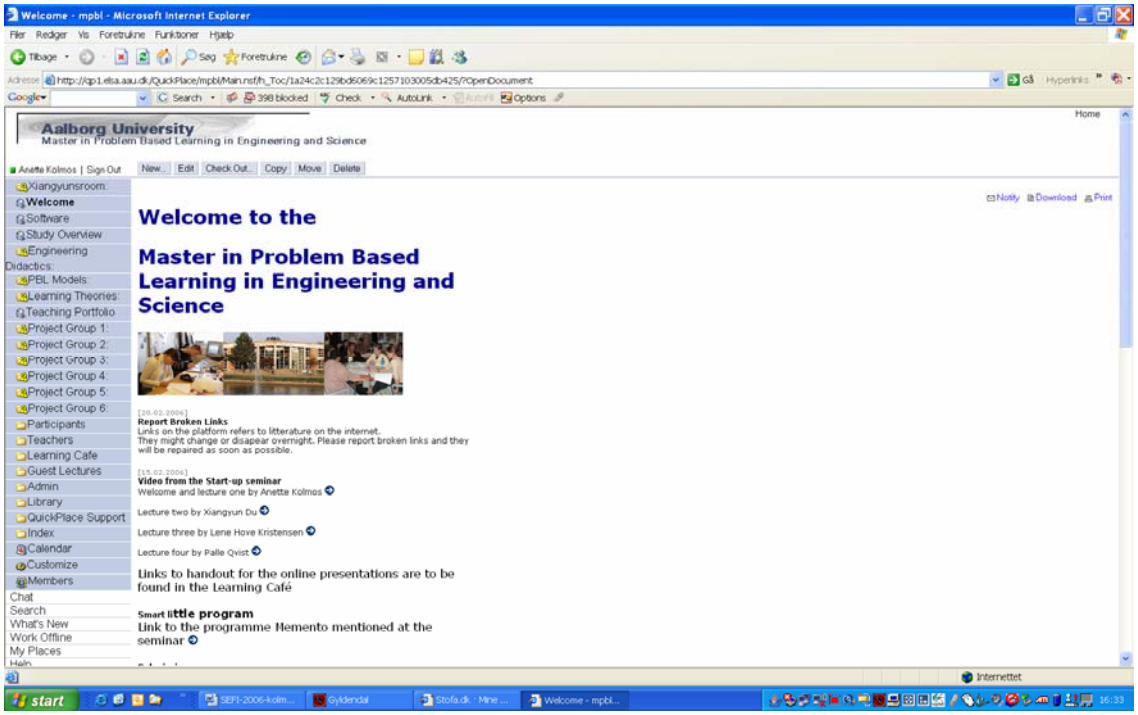
In order to minimize the distance and create better social communication, a non-compulsory two-day on-line ***start-up seminar*** transmitted live has been arranged. This start-up seminar features both participants present in the room and participants watching from a distance. The start-up seminar is placed two weeks after start the formal start of the MPBL-programme. We give the participants two weeks to get familiar with the system and to allow all the technical equipment to get completely up and running. But the start-up seminar must not be held any later as the purpose is to give a starting signal.

Each project group is assigned a facilitator. The role of the facilitator is to enter into dialogue with the participant, give feedback to written work by discussing the structure of the work as well as more detailed issues. In a distance programme, it is important to achieve contact with the participants, thus the facilitator has to get in

contact with the participants within the first three weeks and, after that, schedule regular meetings. These first meetings are run by SKYPE, enabling us to have both video and audio contact with the participants.

4. DESIGN OF THE VIRTUAL MPBL LEARNING ENVIRONMENT

On the basis of the above principles, we have designed the MPBL virtual learning platform as a real university environment.



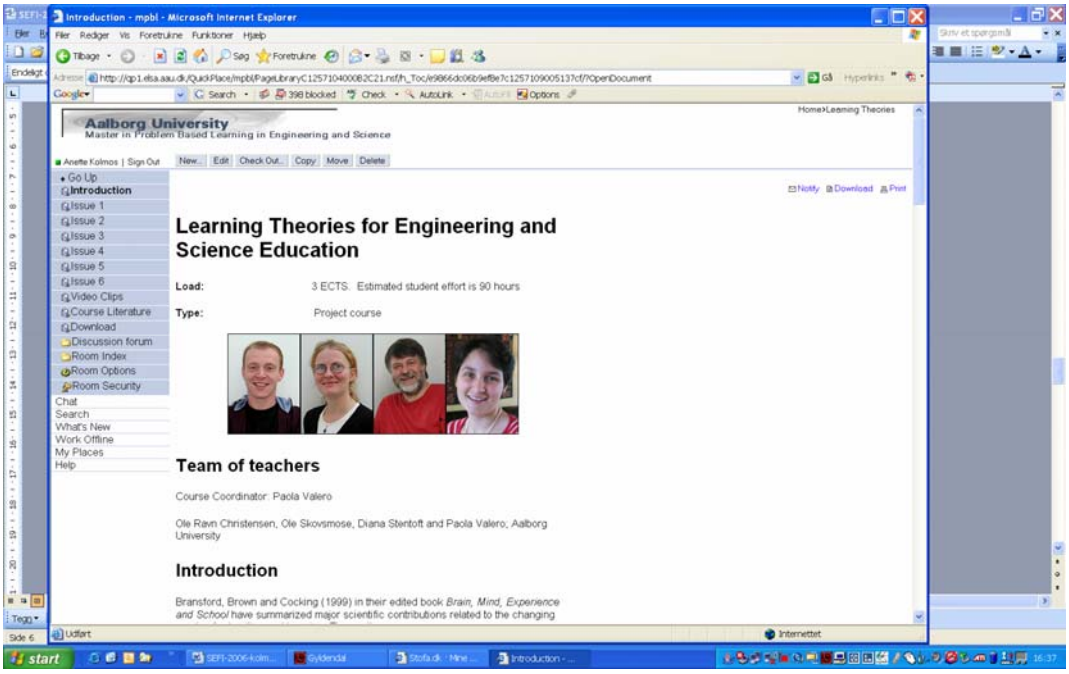
It features information pages such as the
- welcome page with all the latest news
- software information
- recommended overview of the study

Following, are the courses in module 1:
- PBL models
- Learning theories for Engineering and Science
- Engineering Didactics

Next is the description of the project, which in module 1is a teaching portfolio, and all the project groups. Each group has full manager rights in their own group room. Meetings with the facilitator take place within these rooms in the discussion forum.

Finally, the web site has a presentation of participants and teachers, a learning café with small talk, guest lectures in the shape of streamed video presentations from international experts in the area, administration, online libraries, and QP support.

Each course has its separate room. In this room, there will be sessions/issues, on-line lectures, activities to be solved in the discussion forum, or just discussion. The course coordinator will actively seek to further contact with the participants either by SKYPE or by QP discussions.



The first full programme started February 1, 2006 with 20 participants from all over the world; Five from South Africa, three from Australia, one from Saudi Arabia, one from Austria, and the remaining are Danes. In March 2006, we do not yet have the feedback of new students to use in this article. These will be presented at the conference.

However, already now we have experienced the challenges of running a full distance programme at an international level. The challenges are:

- That not all participants have access to the web site. Participants from South Africa do have problems due to the capacity of the broadband. As regards so some participants, we have had trouble using SKYPE and the synchronic facilitation in QP. Participants from the other countries do not have problems getting access.
- To organize quality control. The planning has been going on for so long that links might have been broken and the new version of QP might be too new for operation – there are still errors.
- To establish an entire organization for running a distance programme including description of roles and responsibilities.

Experiences from the first pilot courses concerning contact to the participants have led to a much more active approach compared to face-to-face learning. We have contacted all participants within a short time to make sure that we do have contact. This has had a very positive effect on the level of asynchronic communication at the QP platform. Comparing the level of participants' activity with the level for this cohort, there is no doubt that the personal contact has had an impact. Except for some of the South African participants, all have been active several times.

5. CONCLUSION

At the moment, it is too soon to make any major conclusions concerning the programme. As outlined in the paper, the integration of the PBL learning principles is still on the design level. Although we have begun the MPBL programme and have experience from the first pilot courses, we still need evaluations from participants on the entire programme. At the conference in June, we will present participants' evaluations.

Our experiences concerning how to integrate the learning principles into the design of the MPBL programme are diverse. We have realized the truth in iterative learning processes where we have to go by the trial-and-error method, all the while getting wiser. As explained, we have used three different virtual systems during the planning phase before finally opting for QP.

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Curricula

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Anette Kolmos: professor in Engineering education and PBL and vice director for UCPBL (**U**NESCO International Centre for Engineering Education **C**entre for **P**roblem **B**ased **L**earning), Aalborg University. She was head of the Centre for University Teaching and Learning 1995 – 2002. Dr. Kolmos has been responsible for development and implementation of more than 10 research and development projects. Dr. Kolmos holds a Ph.D. in "Gender, Technology and Education" (1989). Dr. Kolmos is associate editor for the journal: Journal for Engineering Education, ASEE. She is member of the advisory board for The International Journal for Academic Development. Recently been co-editor of special issues on Staff Development for the European Journal of Engineering Education and co-editor of an issue on PBL for The International Journal of Engineering Education. She is member of several advisory boards. She is coordinator for the EU-project, Socrates project, PBL-Engineering which is developing the master programme: Problem Based Learning in Engineering and Science.

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Palle Qvist is a member of the CLP Group (Co-operation, Learning and Project Management). His educational background is in modern history, mass communication, journalism and international relations. He has since 1977 given lectures in PBL at all faculties of the university. He is now teaching engineering students and online international student on the international master programme in problem based learning in engineering and science. One of his main interest are related to PBL and ICT. He is co-author of a much quoted book about PBL and has published numerous web-pages on the topic. He is editor of GRUPPEXperten (The Group Expert), an on-line help site on world wide web. Official website: http://www.plan.aau.dk/~palle

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